Satellite Scatterometer Observations of the Arabian Sea Somali Jet

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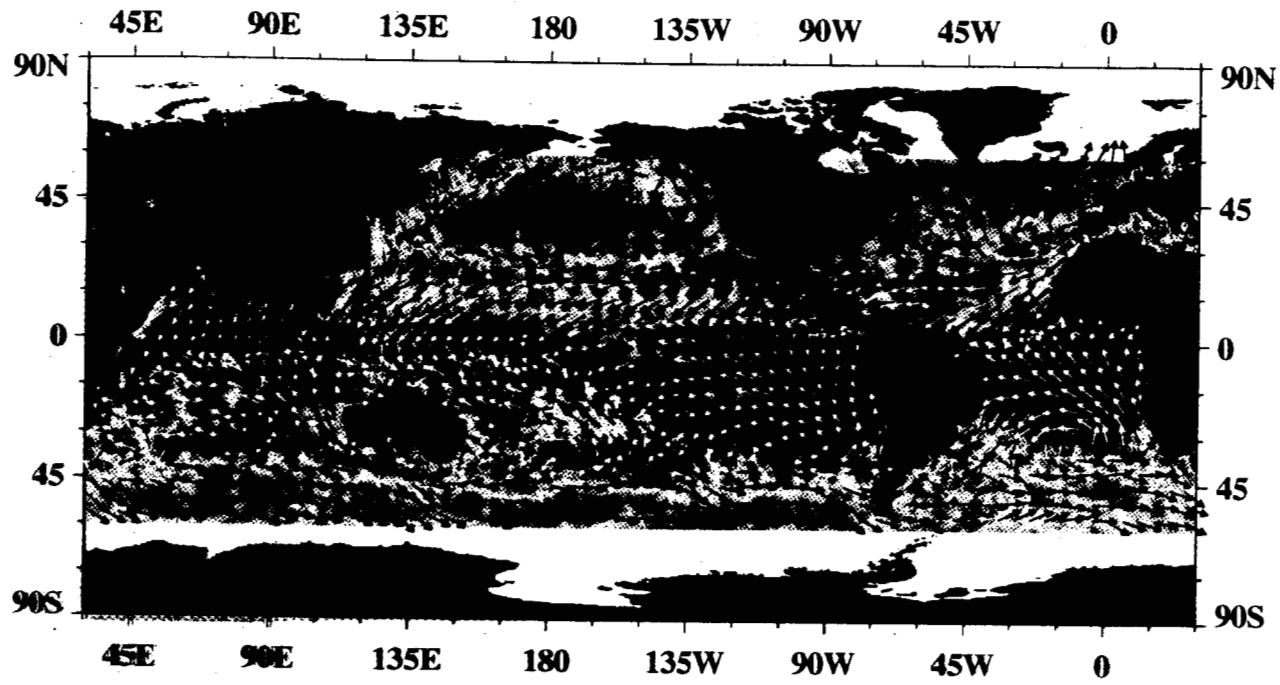
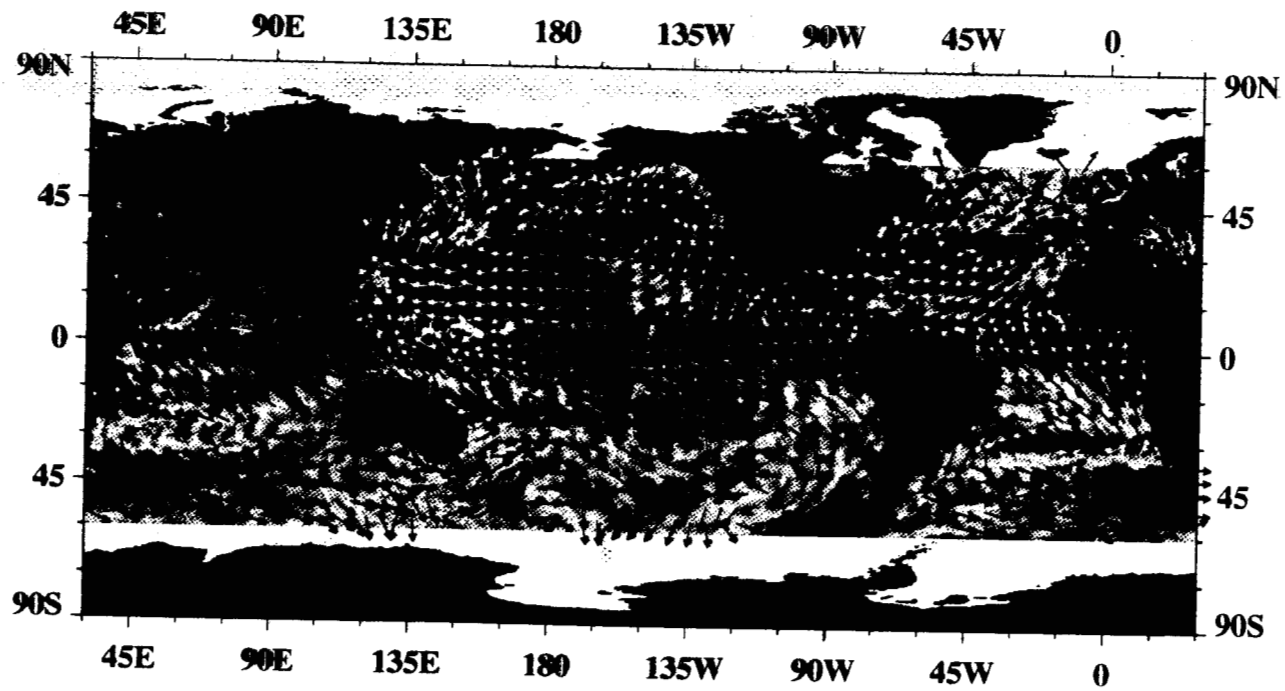
Halpern, D., M. H. Freilich, and R. A. Weller, Arabian Sea surface winds and ocean transports determined from ERS-1 scatterometer. *J. Geophys. Res.*, *103*, 7799-7805, 1998.

Halpern, D., M. H. Freilich, and R. A. Weller, ECMWF and ERS-1 surface winds over the Arabian Sea during July 1995. *J. Phys. Oceanogr.*, *29*, 1619-1623, 1999.

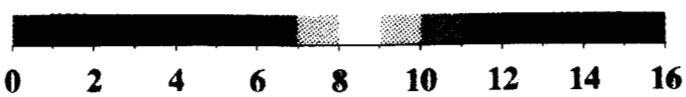
Halpern, D., and P. M. Woiceshyn, Onset of the Somali Jet in the Arabian Sea during June 1997. *J. Geophys. Res.*, *104*, 18041-18046, 1999.



January 1995



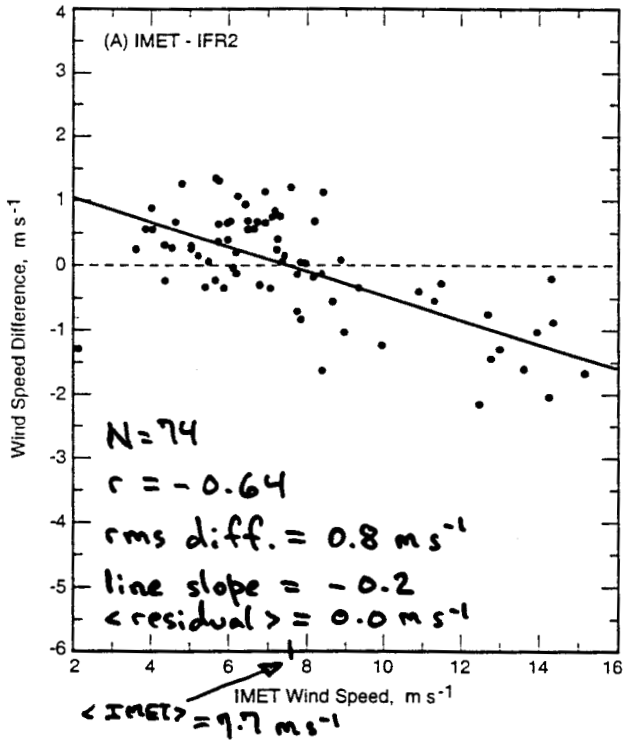
July 1995

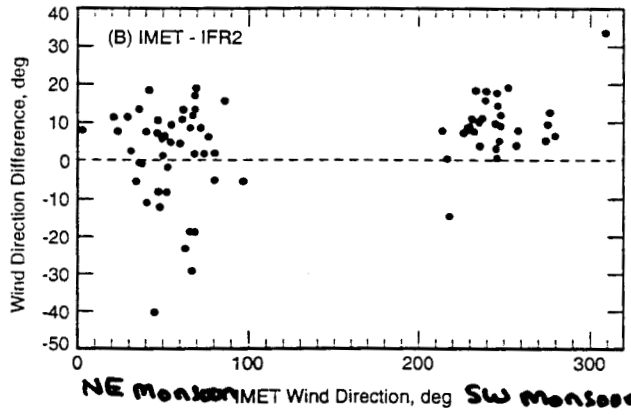


ERS-1 AMI 10 m Wind Vector, m s^{-1}

Halpern et al. (1998)

[IMET, 1-hr centered at IFR2
IFR2, 12.5 km within IMET]





$2^\circ \pm 13^\circ$ $n=43$

$9^\circ \pm 8^\circ$ $n=31$

Halpern et al. (1998)

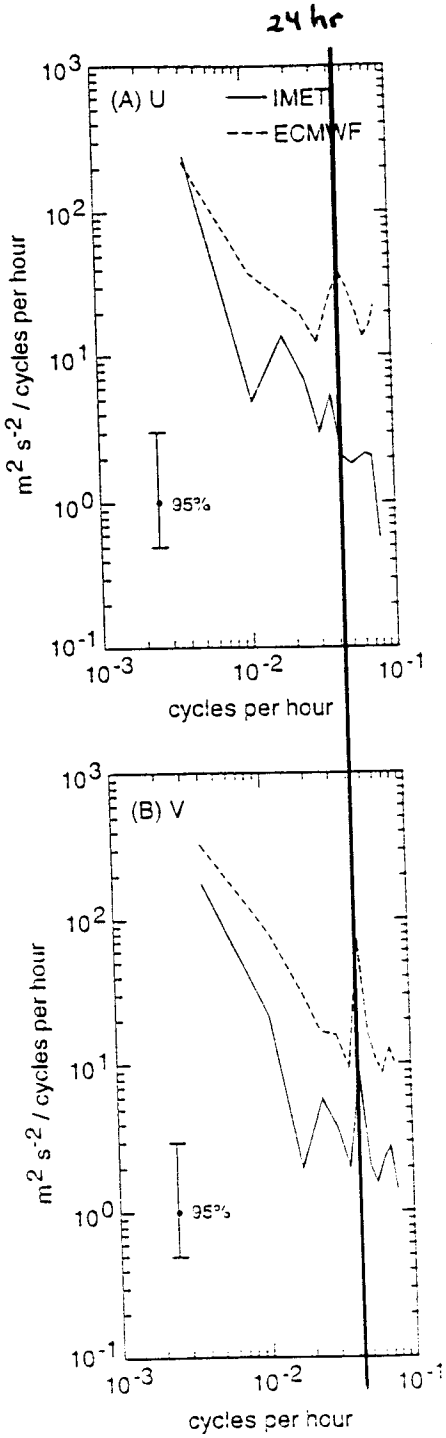


FIG. 3. Frequency spectra of (a) east–west, u, and (b) north–south, v, wind velocity components for IMET and ECMWF data during July 1995. The 95% represents the 95% confidence levels determined from the chi-square distribution.

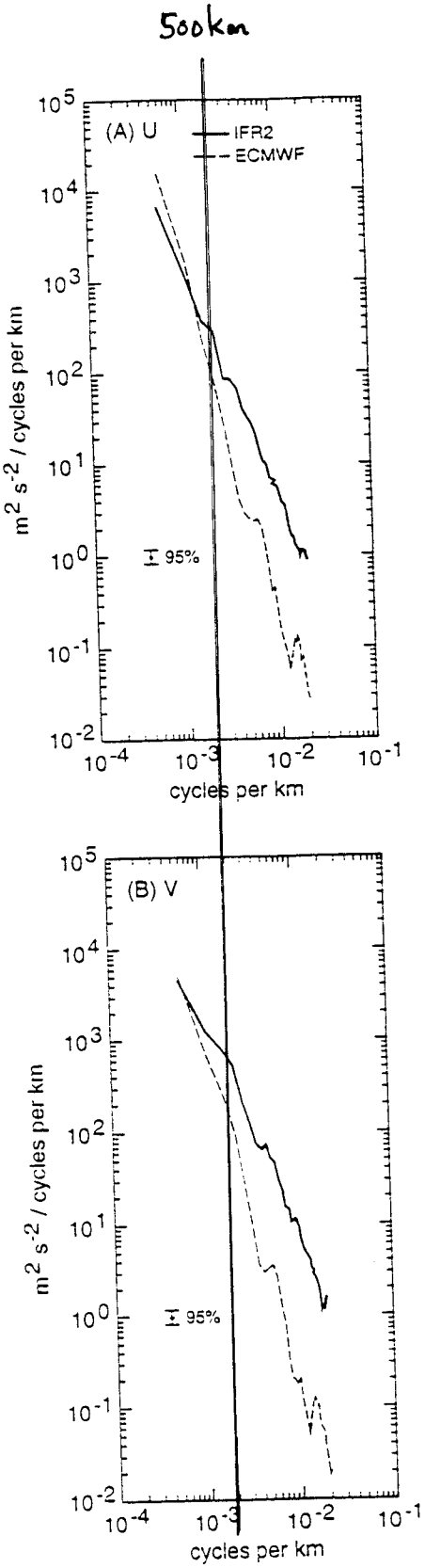
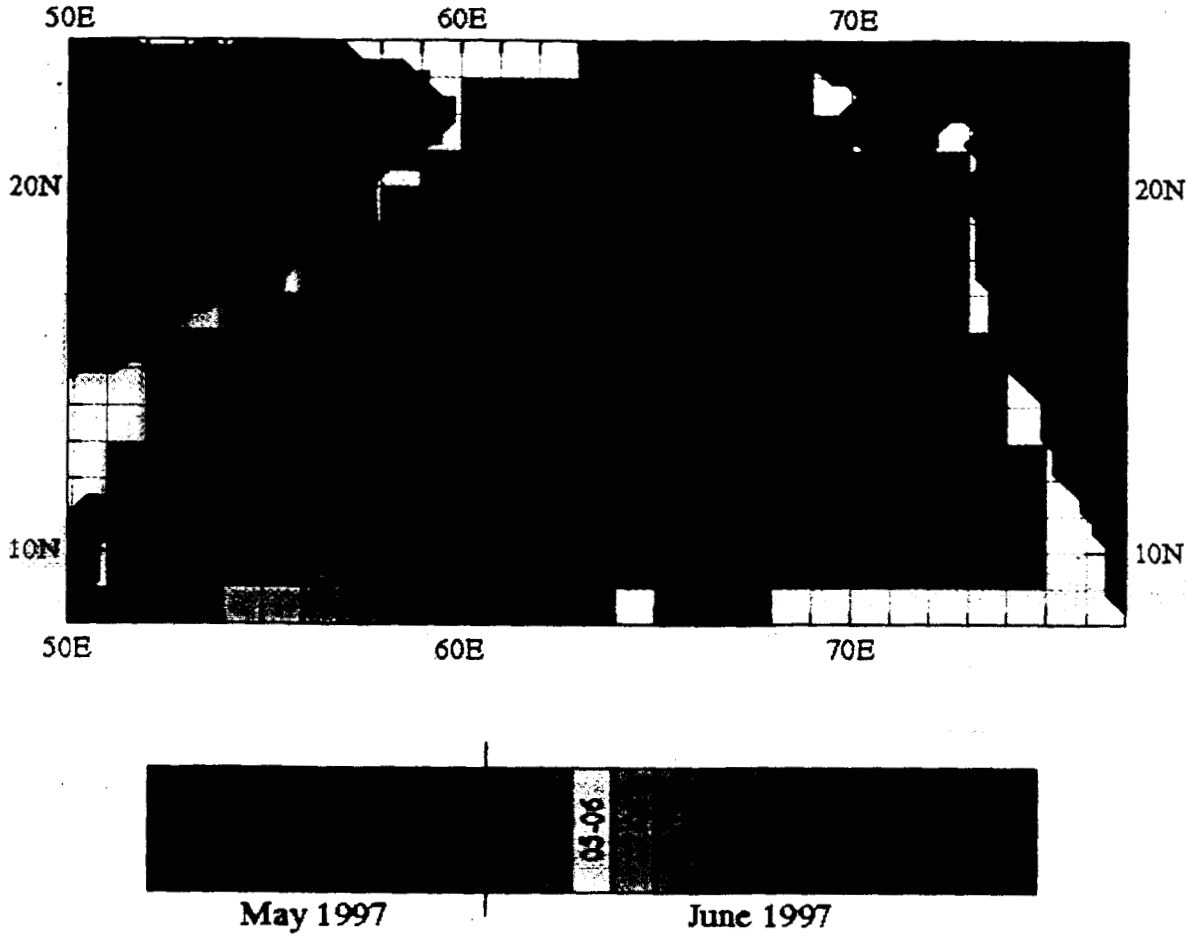


FIG. 4. Wavenumber spectra of (a) east–west, u, and (b) north–south, v, wind velocity components for ECMWF and *IFR2* data during July 1995 in the central Arabian Sea. The 95% represents the 95% confidence levels determined from the chi-square distribution.

Halpern et al. (1999)

NSCAT Provides First Look at Onset of Monsoon Winds

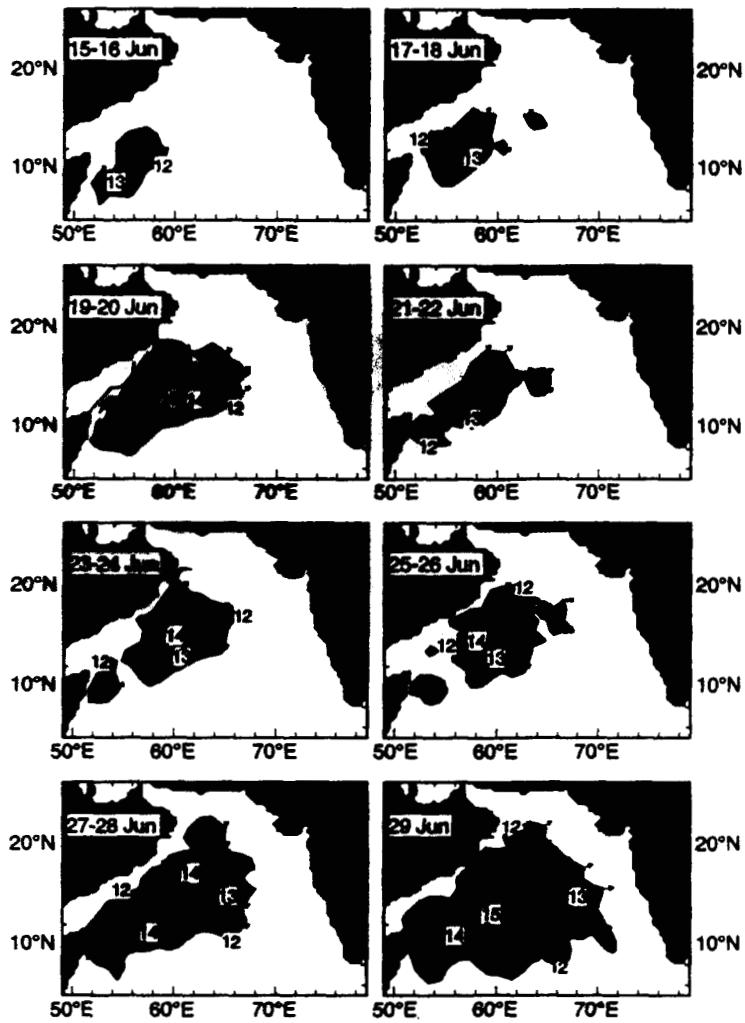


After several months with no rainfall, the arrival of intense southwesterly surface winds over the Arabian Sea heralds the onset of life-supporting monsoon rains to the Indian subcontinent. Until the launch of NSCAT, there were insufficient surface wind vector data to describe the rapid onset of monsoon winds.

The diagram displays times of onset of monsoon winds in the Arabian Sea during May and June 1997. One-third of the entire Arabian Sea had onset times occurring within a 4-day interval, i.e., between 15 and 19 June 1997. Several locations had multiple onsets.

Halpern, D. and P. Woiceshyn, Onset of the Somali Jet in the Arabian Sea During June 1997. *Journal of Geophysical Research, 104,* [redacted], 1999.

NSCAT Provides First Look at Somali Jet Pulsation

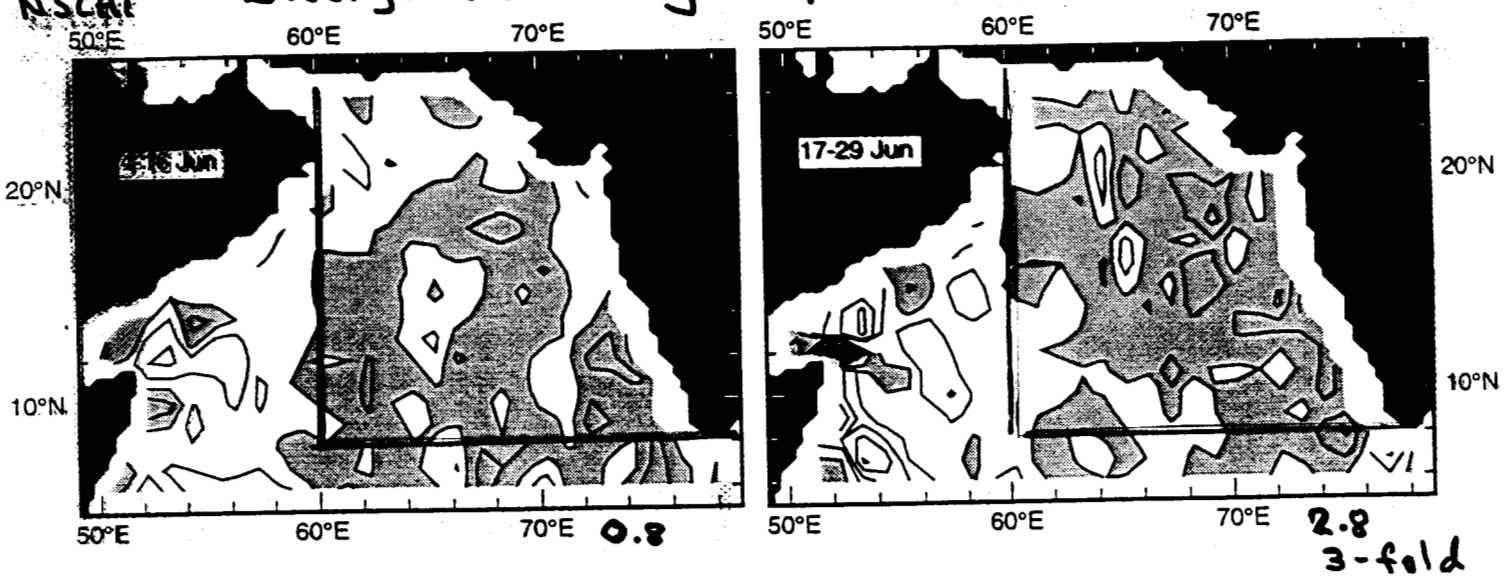


Pulsations of the Somali Jet, which is the intense southwesterly surface winds over the Arabian Sea, were undetected over the Arabian Sea until the launch of NSCAT because of insufficient simultaneous wind vector observations.

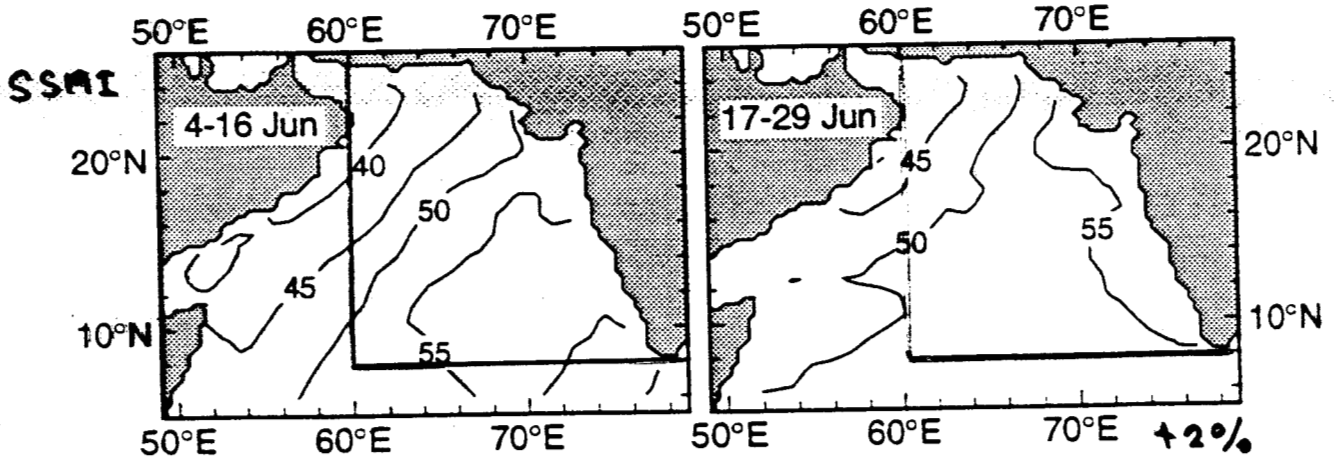
The diagram shows the eastward expansion of Somali Jet high winds (> 12 m s^{-1}) at 2-day intervals. The initial onset of high winds preceded by 3-4 days the time of onset of rainfall in Goa, which is on the west coast of India at about 15°N. Associated with the eastward advance of the Somali Jet were substantial increases in NSCAT-derived surface wind convergence and SSMI-derived integrated cloud liquid water content. Additional studies are necessary to show that Goa rainfall was related to the eastward propagating Somali Jet.

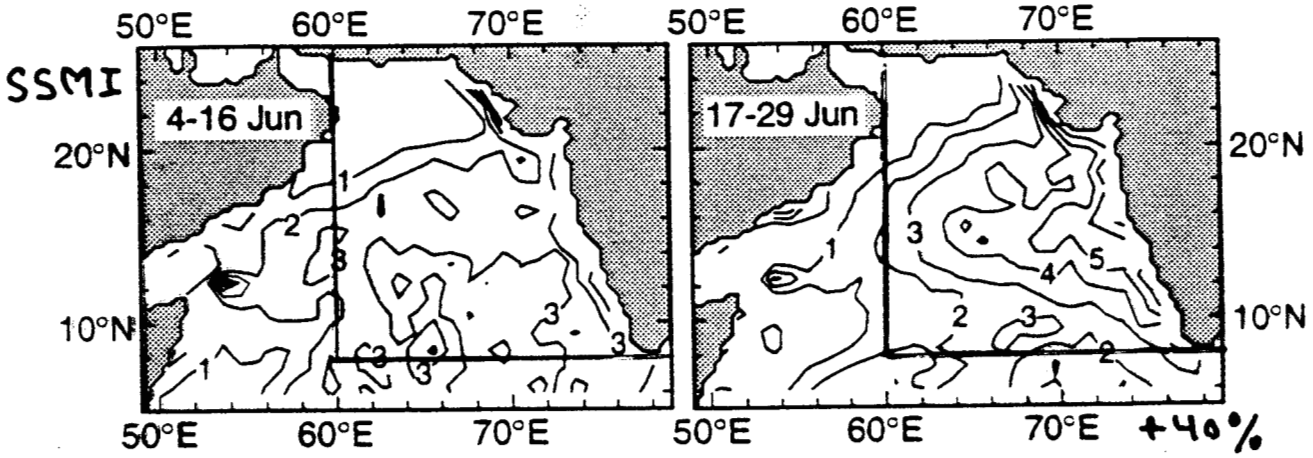
Halpern, D. and P. Woiceshyn, Onset of the Somali Jet in the Arabian Sea During June 1997. *Journal of Geophysical Research*, *104*, [redacted], 1999.

NSCAT Divergence / Convergence, 10^{-6} s^{-1} [CI = 10×10^{-6} s^{-1}]

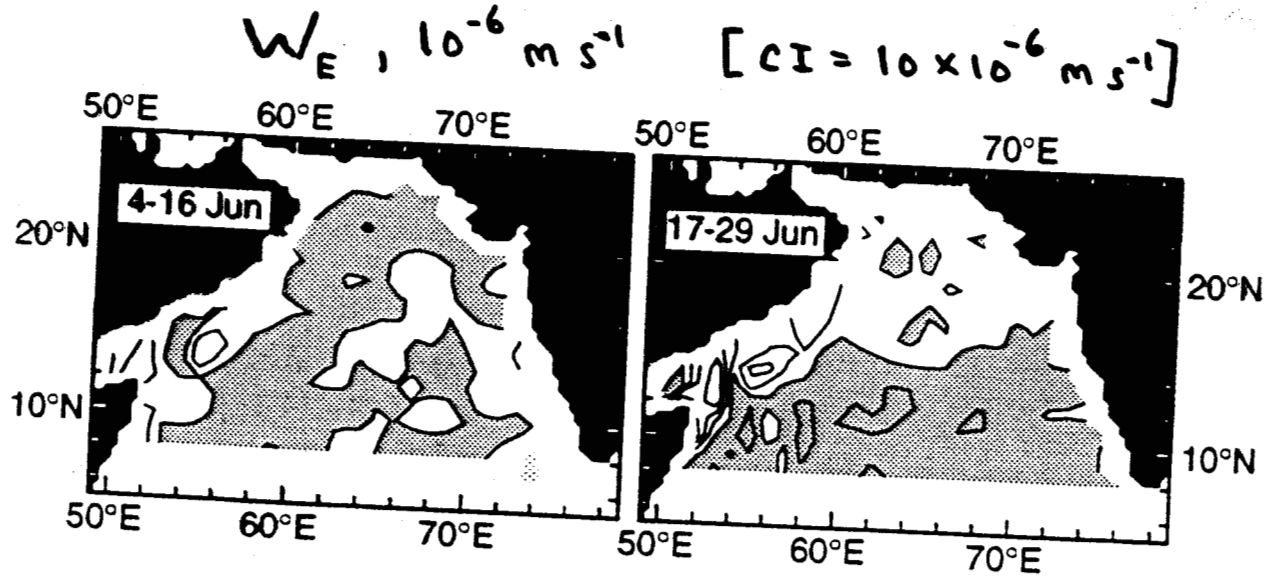


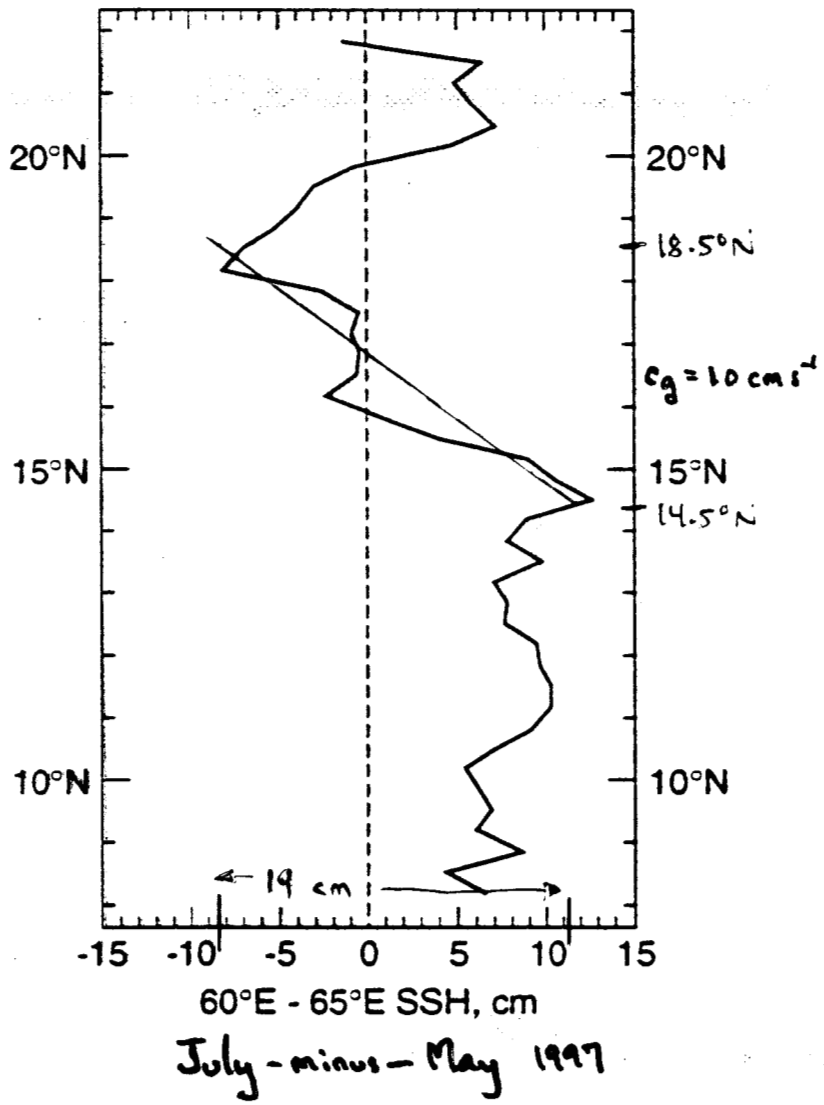
Integrated Water Vapor (Total Precipitable Water), mm





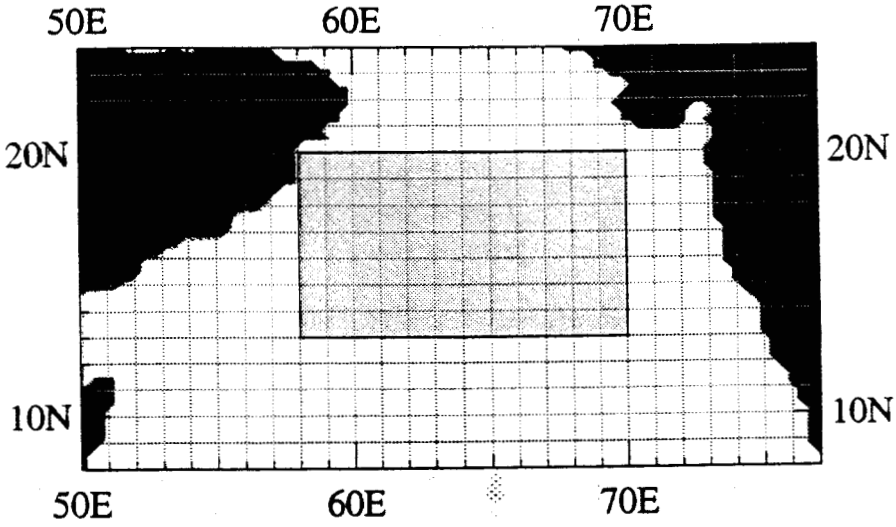
Integrated Cloud Liquid Water Content (0.1mm)

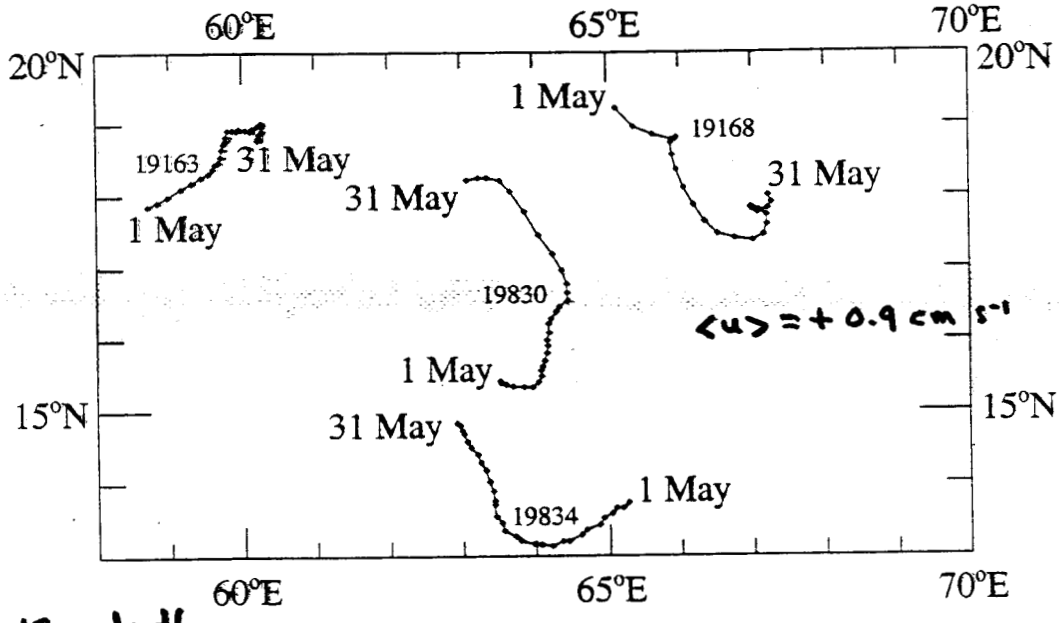




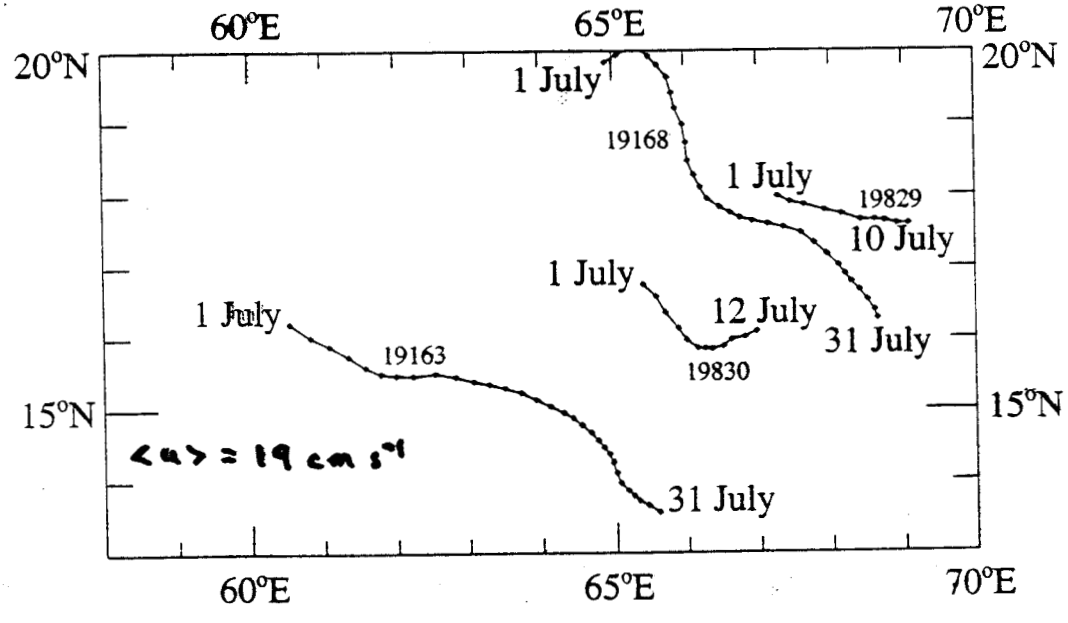
July - minus - May 1997

Daily Buoy Locations in May and July1997

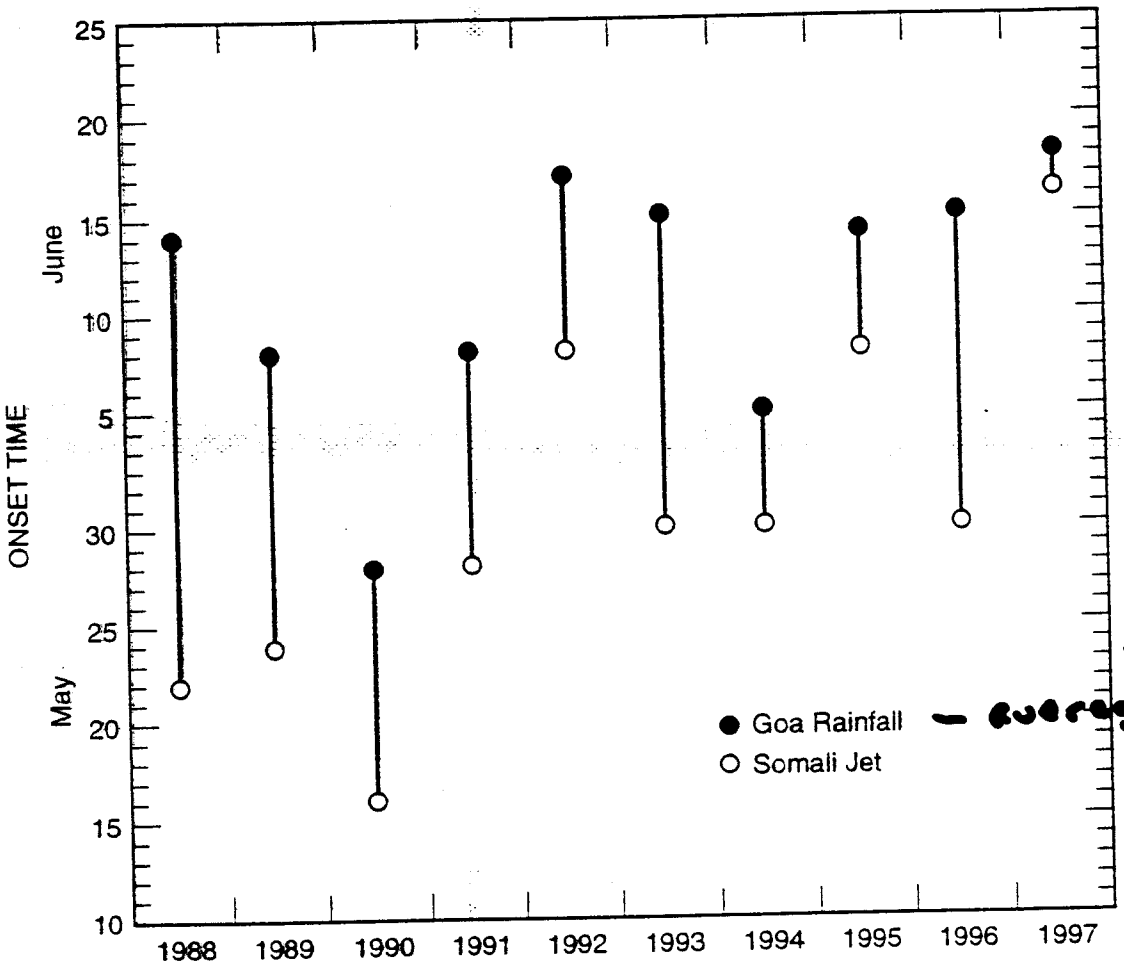




~15m depth

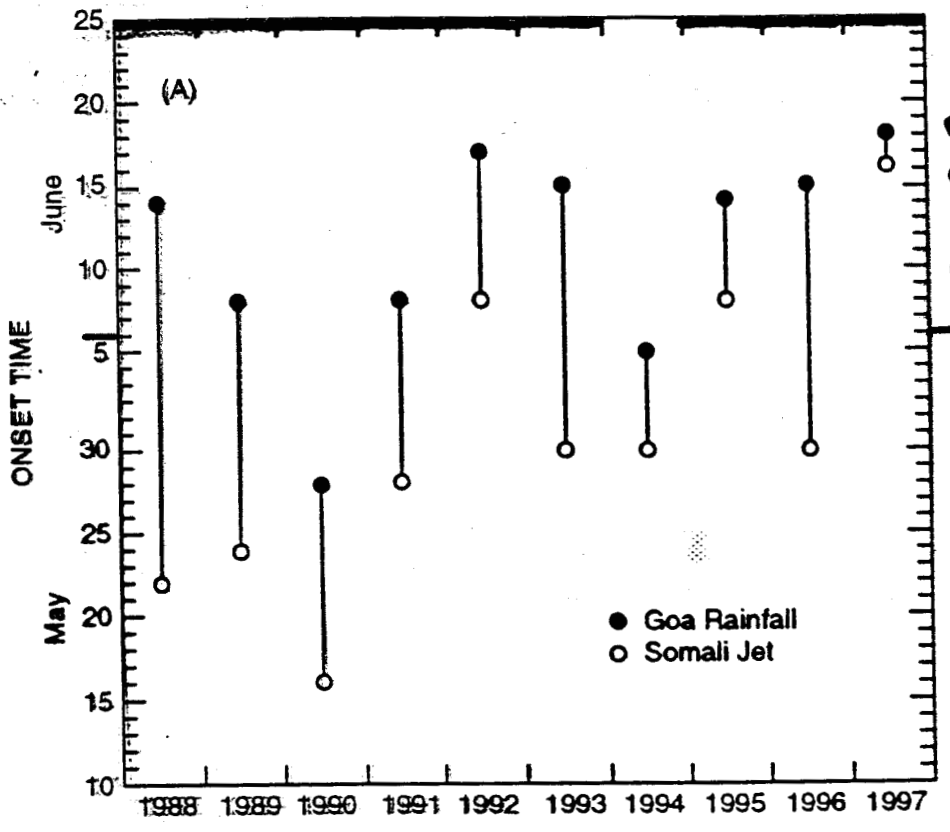


Onset time of Somali Jet always preceded onset time of monsoon rainfall in Goa



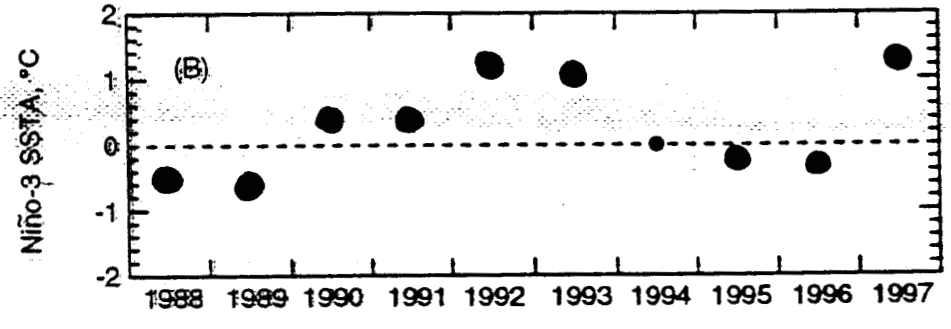
< onset time Goa rainfall − onset time Somali Jet >

= 12 days



minimum time interval occurred in 1997, coincident with El Niño & century average date of onset of Goa Rainfall

onset date_{SJ} always preceded $\text{onset date}_{\text{Goa Rainfall}}$



El Niño: $\overline{SSTA}_{3mo} > 0.2°C$

La Niña: $\overline{SSTA}_{3mo} < 0.2°C$

$\text{SJ onset date}_{\text{El Niño}} = 1 \text{ Jun}$

$\text{SJ onset date}_{\text{La Niña}} = 29 \text{ May}$

$\Delta = \text{onset date}_{\text{Goa Rainfall}} - \text{onset date}_{SJ}$

	Δ, days
El Niño	10
La Niña	15

1988 - 1998

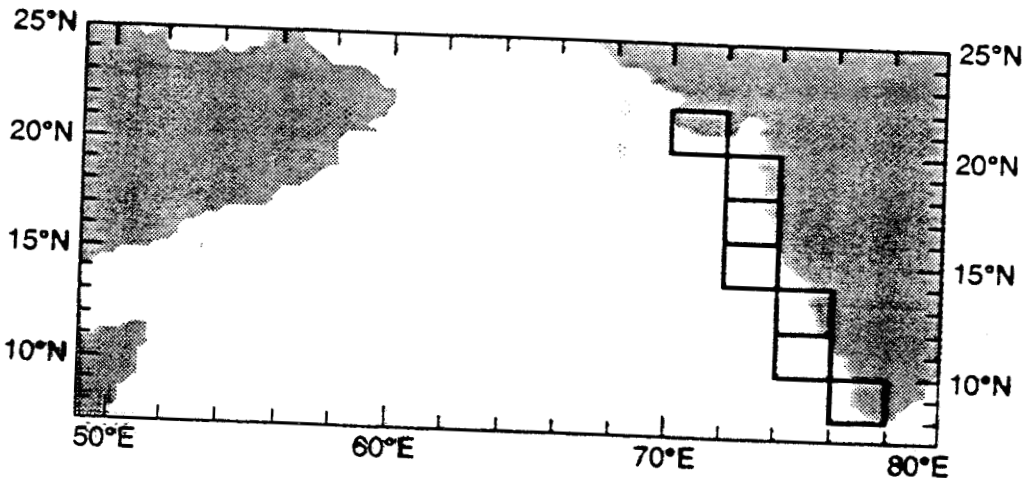
IWCRA — IWCRA

SJWSA > normal

SJWSA < normal

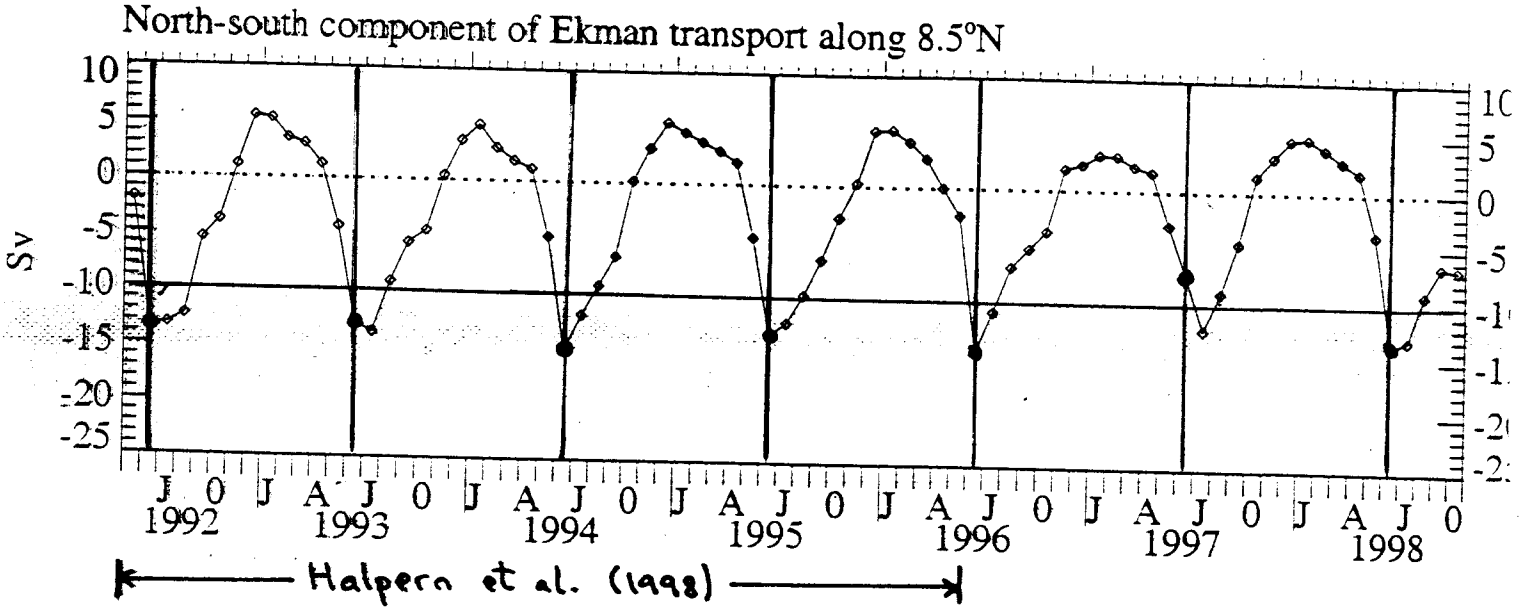
Jun	465 mm
Jul	605 mm
Aug	815 mm

A stronger Somali Jet is associated with excess rainfall along the west coast of India.



Were Arabian Sea surface winds unusual in June 1997?

Meridional component of Ekman transport, $\int_x (-\tau_x/\rho f)\, dx$, along southern boundary of the Arabian Sea at 8°30'N. Unit is Sverdrup, Sv; 1 SV = 1×10^6 m^3 s^{-1}.



June	ERS	NSCAT
1997	-7.6	-7.6
1998	-13.6	
1996	-14.6	
1995	-13.5	
1994	-15.1	
1993	-13.0	
1992	-13.4	

<-13.9>

Δ = 3 Sv ⇒ 2 cm s^{-1} over 50 m

ERS Monthly Mean Wind Vectors, June